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ABSTRACT

Learner-controlled instruction (LCI provides a model for developing the self-directed learners modern society requires. LCI allows the student to specify goals, to control significant resources to attain them, and to choose learning strategies, thus enabling him to learn how to learn. It appears that the environment needed to support this model must rely heavily upon computer-assisted instruction (CAI) and computer-managed instruction (CMI). Time-shared terminals and sophisticated hardware are required, and it is necessary to reorganize content fields for learner-controlled manipulations. Additionally, research needs to identify those who are unlikely to succeed in LCI, to discover how to remedy this problem, and to determine how to structure CAI so that it equalizes the achievements of poorer students without penalizing the better ones, rather than merely amplifying the advantages of the gifted. The TICCIT system at Brigham Young University is being used to field test an LCI program in which learners control the pace, sequence, and mode of instruction, specify the depth and detail of instructional interaction, and determine access to support facilities and advice. Evaluation after two years will determine the success of the system in making operational the theoretical model. (LB)

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INSTITUTE FOR COMPUTER USES IN EDUCATION

"Learner Control of Instruction: Requirements and Potentials"

Fred O'Neal

ICUE Technical Report #2

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DIVISION OF INSTRUCTIONAL SERVICES
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"Learner Control of Instruction:

Requirements and Potentials"

I. The Directions Society Is Taking Place a Premium on Efficient, Self-Directed Learners.

Among the many effects of our technological society has been a proliferation of alternatives. The result is an increasing tendency towards transience in jobs, residences, and social ties. Meanwhile technology proceeds with the establishment of an environment which is increasingly responsive and manipulable. The growing diversity of alternatives, the increasing responsiveness and complexity of the "man-made ecology" and the shifting life patterns this society tends to engender, are all circumstances which singly reward flexibility and the ability to learn, and which in combination will make learning efficiency a paramount life skill.

Speaking of this trend towards diversity and rapid change, Alvin Toffler says:

> ". . . Tomorrow's schools must therefore teach not merely data, but ways to manipulate it. Students must learn how to discard old ideas, how and when to replace them. They must, in short, learn how to learn. . ."

He quotes psychologist Herbert Gerjuoy of the Human Resources Research Organization:

> "The new education must teach the individual how to classify and reclassify information, how to evaluate its veracity, how to change categories when necessary, how to move from the concrete to the abstract and back, how to look at problems from a new direction--how to teach himself. Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn." (Toffler, 1970)

As usual, education is slowly responding to, rather than anticipating new circumstances and needs. While conventional educational structures are now beginning to pay greater lip service to increasing their flexibility in the individualization of students' learning programs, it is clear that they are still feeble measures indeed when viewed in light of the potential complexity of the life for which the student is to be prepared.

McLuhan says:

> "We are actually living out the paradox of having provided cities that are more potent teaching machines than our formal educational system. The environment itself has become richer. We seem to be approaching the age when we shall program the environment instead of the curriculum." (McLuhan, 1966)

While you may or may not agree with McLuhan, any inspection at all of education as it stands today will show considerable room for improvement in preparation of the student for a lifelong career of learning.

II. Increasingly Sophisticated CAI-CMI Models Offer Learner More Responsive and Flexible Learning Environments - Trend Towards Learner-Controlled Instruction. - What Is L-C?

This paper will briefly discuss one proposed method for so preparing the learner, and until a better phrase is coined we will call it "Learner-Controlled Instruction" (L-C).

As hardware capabilities improve for interactive systems of the types appropriate for instruction, and as software and courseware become more sophisticated, it is becoming possible to provide the learner with more and more manipulative tools. These tend to

increase the flexibility of the courseware and personalize learner-system interactions. Learner-Controlled Instruction can be said to represent an extreme projection of this trend, where the learner is given enough of these tools so that he can be considered really in control of the interaction, while the system provides learning resources and facilities for their manipulation.

For purposes of this presentation, we can discuss L-C in terms of three dimensions, Goals, Strategies and Resources - These can be roughly defined by the questions:

1. What does the learner want to do? (Goals)
2. How does he want to do it? (Strategies)
3. What does he need to do it? (Resources)

One major constraint placed upon the learner by most conventional educational structures is in the area of goals. There is no more provision in most course offerings for satisfaction of a range of student goals, than there is for a range of student abilities or backgrounds. A learner may be fulfilling a prerequisite, satisfying an interest through an elective, or merely investigating an unfamiliar area by taking a course as an introduction. In all three cases, however, the learner will probably get the same course, and will be subjected to the same mastery model. There is little or no provision for a "survey" or "review" mode in most courses. There is no convenient way for a learner to skim the surface of a course at his own pace, to establish its utility for his goals. Auditing cannot accelerate the tempo of interaction, selectively edit content, or control the sequence of experience to satisfy the needs of a learner whose goal is to survey an unfamiliar course or review a previously encountered body of subject matter. In addition, it is time-consuming

and often expensive. One area where education is improving rapidly, however, is in the area of accepting competency in lieu of course-work. A student whose goal is accreditation for already mastered skills and knowledge has an increasingly good chance to "test out" of a course. However, the opportunity is by no means universally available, and most often is limited to lower level courses. It is apparent that to the extent any instructional system is truly "Learner-Controlled" there must be provision for learner to attain a variety of goals including at least:

1. Review of previously encountered material.
2. "Survey" or "Exploration" of unencountered material.
3. Credit according to a range of mastery models. (A-B, Pass, Prerequisite Credit, etc.)

If the student's goals are to be achieved under true L-C, he must be afforded control in two other areas: Strategy and Resources. It is meaningless to speak of L-C unless there are significant instructional resources to be controlled. Resources constitute a broad area generally defined here to cover the tangible materials of instruction including the instructional materials and their necessary delivery or peripheral devices. Classified as instructional materials are such items as objectives, hierarchy maps, practice test items, diagnostic tests, mastery tests, graphics support, content organized and presented in a variety of ways, some sort of "score keeping" to allow the learner to judge his progress against his goals, manipulable models, real life experiences and so on.

Having let the learner choose his goals, and having provided him with resources to attain them, it must now be up to him (and this is the most important thing of all) to exercise control over <u>how</u> he

will use the resources available to attain the goals. He must learn how to learn. This implies that a L-C system must provide the learner with control over such variables as sequence, pacing, mode (practice or exposition), difficulty level, detail, resource selection, media, memory load, and so on.

In the final analysis it is the area of strategies which must justify L-C. It is hoped that learners who set their own goals and who have learned optium personal strategies for utilizing available resources to attain them, will be able to flexibly and efficiently adapt to new learning circumstances. It seems likely that, initially at least, L-C will not be as efficient in terms of content mastery as specifically engineered instructional strategies. However, if an efficient, self-directed learner is to be produced, it is important that the learner be induced to exhibit the terminal behavior (that is to practice L-C skills) as early as possible. L-C cannot be taught in a vacuum. There must be a content field to manipulate for achievement for some defined mastery model in order that the efficiency of L-C strategies might be assessed and modified. It seems appropriate, therefore, that content mastery and L-C skill mastery be concurrent objectives.

III. What Will Be Needed To Provide a Learning Environment in Which a Range of Goals Can Be Accommodated, an Appropriate Set of Learning Resources Provided, and a Variety of Strategies Implemented?

It seems apparent that a major component of any instructional system designed for L-C must be a CMI-CAI system. The problems of

individualizing resource allocation and strategy implementation are properly CMI-CAI considerations. For this reason it is probable that L-C systems will share many characteristics with CMI-CAI systems. Time-shared terminals will be a primary learner-system interface. As terminal characteristics continue growing more sophisticated, the richness of the learning environment will increase. Color, video and photographic as well as dynamically generated graphics, some audio applications, plotters, and a variety of hard copy terminal devices are becoming available. Prices too are improving. Those concerned with the economics of interactive systems will be encouraged by the Carnagie Commission Report of 1972 entitled, The Emerging Technology. The report compares the best available reports on cost trends and subsequent predictions as to future cost trends in the areas of CPU and terminal hardware, communications, memory and storage devices, instructional software, and supporting services, and concludes that, using the most conservative reasonable figures, that costs of 50-75 cents/student hour or less are almost inevitable within a few years, and within 5 to 10 years costs attributable to central computer hardware should become insignificant! The critical cost factor, they predict, will be distribution.

Effective L-C systems call for some new developments outside the hardware area, however. The most obvious requirement for new development lies in the constitution and organization of the content field for L-C manipulation. For example, the courseware must be so organized that it can be manipulated by the learner in a variety of strategies. It must be comprehensive enough to provide sufficient instructional background

to fulfill the most rigorous of its intended objective levels (most likely accreditation or an achievement of a given skill level prerequisite for some purpose). At the same time it must be amenable to manipulation for achievement of a variety of less rigorous goals, such as review, surveys of varying depth, or use of selected subparts of the content in different modular arrangements for fulfillment of alternative objectives.

Experience in the use and sophistication in the development of CMI and CAI techniques are advancing well, albeit more slowly than was often initially predicted by many. Although some CMI-CAI models now offer the learner a set of limited control functions, such things as content analysis and organization of courseware into structures with the characteristics necessary for really sophisticated L-C have been more neglected. At least one group has made a very good start, however, and a full-scale test of their progress will be soon forthcoming.

IV. Learner-Control Questions Which Must Be Answered

If it can be shown that L-C has social, instructional, or other advantages that justify its further development on a broad basis, several unanswered questions will need resolution. For one, the intuitive premise that there will be "learner-controllers" (learners who can effectively manipulate the learning environment) and "non-learner-controllers" (relatively speaking) needs to be empirically established. This done, the sequence of inquiry proceeds almost inevitably through the question, "If there are learner-controllers

and non-learner-controllers, do they have identifiable characteristics?", to the important question, "Can identified non-learners-controllers be taught to become learner-controllers?"

This last question is of extreme importance. Bereiter, in commenting on Jensen's position on the heritability of IQ (Bereiter, 1969), comments on the cognitive demands of technological society. He speaks of "amplifiers" and "equalizers". He points out that some of society's devices, structures, and resources are amplifiers. For example, anyone using a lever can lift more, but in a case where both a strong man and a weak man can each lift twice as much with a lever as they could unaided, the strong man still lifts more than the weak man, and in fact his absolute advantage is increased!

Bereiter also talks of "equalizers" such as the electric hoist. Both the strong man and the weak man can lift the same amount by pushing the button. The disadvantage of the weak man has been overcome, but not at the expense of the strong. Bereiter's analogy holds true for rich L-C learning environments. It is apparent from even relatively primitive CAI instructional materials that performance differences of literally hundreds to one can be encountered in heterogeneous groups of learners using the same materials. In fact, upon reflection, it is easy to conclude that the main reason the phenomenon is not even more pronounced is that the materials often have built-in "ceilings" that "keep-the-lid on" the advantaged learner. Either the sequences are too short for the good learner to really get rolling and compound his advantages, or the (for him) unnecessary extra interactions or administrative overhead of the lesson's structure either dilute, or prevent him from really exercising, his advantages. A

true, rich, L-C learning environment, however, cannot help but operate as an amplifier of the most effective sort. The effect of the advantaged learner increasing his advantage over less efficient learners will only intensify, as the learning environment is made more complex and potentially powerful.

What will clearly be needed is some sort of "equalizing" factor. This can, perhaps, be best provided by applying the best available knowledge from learning research in conjunction with the best information on the learner's performance, in directing strategies. It would be even better if this direction could be instructive, with the desired end being that, as the learner is instructed in good learning strategies, the directions could be phased out, and an effective, self-directed learner would result.

In any event, the answers to questions regarding L-C are, for the time being, difficult to come by. It is by no means apparent that studies isolating such L-C variables as L-C of sequence, pacing, amount of practice, feedback, and so on, singly or in simple combination, adequately reflect what will be transpiring in the complex and highly interactive L-C environments now being developed. What is needed are data on large groups of learners exposed for significant lengths of time in L-C environments more sophisticated than any heretofore available. The first such opportunity promises to be available within the year.

V. TICCIT

Let us consider a system now in advanced stages of development that offers perhaps the most responsive and extensive L-C environment yet attempted, the TICCIT system. TICCIT hardware, software, and courseware will undergo testing on students at BYU this school year, and next year two systems will be in full-scale operation with several thousand students at Junior Colleges in Virginia and Arizona.

While the institutions involved have specified that the terminal goal of learners on the system is to be mastery for credit, the learner can still exercise control over strategy considerations and content resources. He will be able to survey any material or review any material he has already passed.

Within the system the learner may exercise control through an initial set of 23 control functions. The origins of many of the L-C functions in TICCIT may be detected in those options which gradually have become available in the maturing CAI curricula of many installations. The University of Texas, HUMMRO, and Kansas City Public Schools CAI courseware, among many others, demonstrate this trend. The implementation of these functions also has detectable philosophical origins in earlier thinking. Pask's (Pask, 1967) ideas on levels of discourse have been adapted and applied by Fine (Fine, 1972) and Bunderson for TICCIT. The L-C functions on TICCIT constitute a high-level language of the order of Pask's L^2 level. This L-C "language" is being implemented through software interrupts, initiated from the keyboard, or from key-word menus accessed by the keyboard. The TICCIT learner may control his pace, sequence,

amount of practice, instance mode (inquisitory or expository), and grade aspirations. He may control the depth or detail with which he interacts with the content. That is, he may approach it any place on a spectrum ranging from a very terse, technical, and general level, to an instance - specific and extensively detailed level. He may change the difficulty level of instances, rules, or definitions, to Hard, Medium or Easy at any time. He may roam relatively freely forwards and backwards through the strategy sequence he has created and he has access to resources such as objective hierarchy maps which incorporate status displays reporting his progress on the lesson, unit or course level. He may request CALCulator support where appropriate, hard COPY of non-test frames, videotapes or mini-lessons (graphically supported lesson summaries), or he may make comments (NOTE) for the record at any time he wishes. While in REVIEW mode, he may request the ANSWER to any question. He may EXIT most procedures he has initiated at any time he wishes, or REPEAT any procedure he has just finished.

Most important of all, however, is the availability to the learner of ADVICE. There is an ADVISOR program which serves four functions:

1. Helps a new student use the learner-control structure on which TICCIT is built.
2. Helps all students in developing learning strategies,
3. Provides only limitation on Learner-Control structure by preventing student from accessing lessons or tests for which he is not prepared, and,
4. Provides limited content advice about numbers of instances the student should see, and the "best" sequence to follow.

This function, actually a complex table driven decision-making program, allows for the input of "expert" opinion. The student may ask for ADVICE, or, at any time the ever-present ADVISOR has sufficient information to make a recommendation, it will do so unsolicited. However, most of these recommendations may be overruled by the student. An important exception is that the ADVISOR will prevent the student from taking any material which the authors have designated absolutely shall not be attempted until the student has first completed necessary prerequisites. Another is that the ADVISOR requires a specified minimum amount of work if the student has failed a test before it will allow him to try it again. These are two of many necessary ad hoc decisions which can and will be modified when sufficient data become available.

And this is the real promise of the TICCIT courseware design. The simplicity of its table driven logic will yield easily to empirically indicated modifications. In the meantime during the coming two years, TICCIT should provide an invaluable test bed for L-C research in the richest large-scale L-C environment yet available.

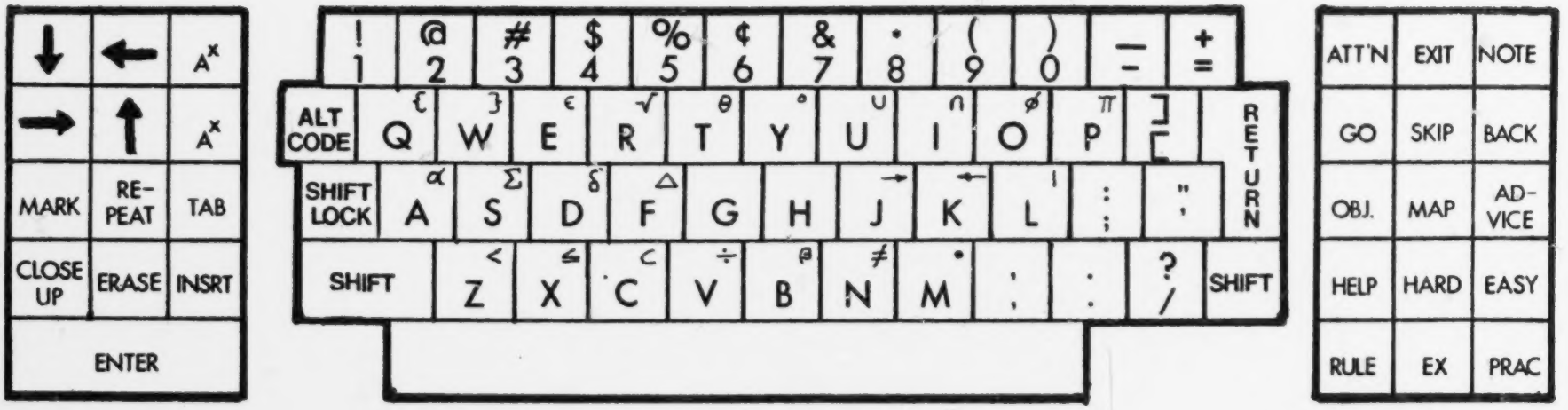
It is necessary that the first approximation of TICCIT be effective enough to allow a "bootstrap" effect. While it is admitted that such an ambitious L-C system should be based on solid research findings, such findings are not going to be available until relatively sophisticated systems are constructed for experimentation. The obvious expedient for such a "chicken or the egg" problem is to be as TICCIT has done, apply such research as seems to apply,

construct as good an initial system as possible for data gathering and evaluation, and modify as results indicate.

The last two years have been challenging as the system concepts have matured, but the next two years will be even more exciting, and who knows, they may be the beginning of a whole new look in education.

Learner Control Keys

Learner Control Keys



TICCIT KEYBOARD (MATH)

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